Benefits and costs of having bank and trade credit simultaneously

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Abstract

This paper provides a rationale for the question whether to have bank debt only or bank and trade credit simultaneously. In the two creditors case a special incentive problem might occur prior to bankruptcy if the bank loan is secured by external collateral. In order to save her private fortune, the entrepreneur may be tempted to repay the bank by liquidating the firm's assets before bank debt becomes due. Even the bank might benefit. The unsecured supplier will lose. With pure bank financing - thus, paying the supplier via the bank account - the problem does not occur. However, then the supplier may have poor incentives to provide non-verifiable services later on. Collateral and short-term dates of payments mitigate the entrepreneurial moral hazard problem.

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1. Introduction

Many firms have both bank and trade credit simultaneously. This paper shows that there are benefits and costs of having both bank and trade credit. It derives equilibriums for pure bank financing and for simultaneous bank and trade credit.

We are looking at a limited liability firm with a manager-owner and two possible creditors: a bank and a supplier. When there are two creditors a special moral hazard problem might occur prior to bankruptcy if the bank loan is secured by external collateral. In order to save her private fortune, the entrepreneur may be tempted to repay the bank by liquidating the firm's assets before bank debt becomes due. Even the bank might benefit if her claim was risky. The unsecured supplier will lose. To our knowledge this special moral hazard problem has not been addressed in the economics literature so far.

This type of opportunistic behavior might incur a welfare loss if (a) the supplier does not (fully) anticipate and thus, the entrepreneur quickly liquidates firm's assets in a "fire sale". With a fire sale the liquidation revenue is supposed to be lower than with a "normal" liquidation. This is one source of welfare loss. If (b) the supplier anticipates he might reduce the amount of trade credit and, as a consequence, the extent of services in the first place. As a consequence, the entrepreneur might not be able to undertake a project with a positive net present value (*underinvestment*). High interest rates might also compensate for the special risk the supplier incurs. They are quite common in practice. Interestingly, external collateral might induce a welfare loss whereas the literature points out the welfare improving effect of external collateral.

There is an alternative to the two creditors case (also called: mixed financing). The supplier's claim can be fully paid via the bank's account. The bank is the only creditor then (pure bank financing). However, then the supplier has poor incentives to provide non-contractible services later on. One might think of guarantees promising services if a malfunction occurs and if the type of malfunction or the nature of services cannot be precisely described ex ante or if it is too costly to do so. Thus, also with pure bank financing a welfare loss might occur. If the supplier is not paid (if there is trade credit) he has stronger incentives to perform.

There are two (observable) contractual solutions to mitigate the moral hazard problem in the two creditor case. First: valuable internal collateral. Internal collateral is only valuable if the entrepreneur cannot sell the item without the supplier's consent. Still, this happens if the sanctions are too soft or if the legal setting is vague as it is in some

jurisdictions, e.g. in Germany. Second, the supplier demands quick payment. This reduces the probability that the bank is served first. Thus, this paper explains the wide use of short-term dates of payments.

This article contributes to the literature in several ways. First, it shows a moral hazard problem (premature repayment) that has not been mentioned in the literature so far, but certainly is of importance in reality. Second, it explains widely used features of trade credit. Third, it shows that external collateral might *induce* a moral hazard problem. Fourth, it shows that *internal* collateral mitigates this problem. Fifth, it provides a model explaining the optimal choice between bank and trade credit (see also *Biais/Gollier*, 1997)

The corporate finance literature mainly addresses conflicts of interest between the entrepreneur and her creditors but hardly considers conflicts of interest *between different creditors* (see for instance the surveys in *Harris/Raviv*, 1991, *Hart*, 2001). Some papers in the law and economics literature look at creditor conflicts with regard to the financing or investment policy (*Bulow/Shoven*, 1978, *White*, 1980, *Gertner/Scharfstein*, 1991, *Bebchuk/Fried*, 1996 and *Bigus*, 2002), however not with regard to repayment policy. Moreover, those papers do not provide a model on the optimal choice of bank and trade credit.

There is another strand in the banking and corporate finance literature asking why firms have different creditor at all (see *Berglöf/von Thadden*, 1994, *Hart/Moore*, 1995)[1] or what the optimal number of creditors is. *Hubert/Schäfer* (2002) assume, that banks have special skills in reorganizing financially distressed firms. With many creditors co-ordination becomes costly and efficient reorganization is more likely to fail. It would be optimal if the bank was the only creditor then. There is a disadvantage of having only one creditor, though. The bank is tempted to hold up the entrepreneur in renegotiations (*Rajan*, 1992). The more creditors there are the less likely a hold-up is to occur. The optimal number of creditors is determined by the welfare loss incurred by the severity of each of the counteracting effects. *Detragiache/Garella/Guiso* (2000) argue, that liquidity problems due to legal restrictions are less likely to occur the more banks the firm has debt with. However, as the number of bank increases, the costs of evaluating the project's prospects are increasing, too, since some part of the cost is fixed. Again, there is an optimal number of creditors.

[1] The models of *Berglöf/von Thadden* (1994) and *Hart/Moore* (1995) show that different types of debt might be useful in mitigating entrepreneurial hazard. Our model differs in two respects. First, it shows, that different creditors are useful to mitigate opportunistic behaviour by a creditor (supplier). Second, it points out that there might also a special social loss when there are two different creditors.

Thus, there is no model so far that addresses welfare losses due to inefficient *repayment* policy. In what follows, we first show the model in chapter 2 presenting the assumptions (2.1) the outcome of the subgames "pure bank financing" and "two creditors financing" (2.2 and 2.3, respectively) and the possible equilibria (2.4). Chapter 3 deals with the question which contractual provisions might be suitable to overcome the welfare loss with two creditor financing. Chapter 4 summarizes.

2. The model

2.1 Trade credit: empirical and theoretical findings

A considerable amount of corporate debt is held by suppliers, and not by banks only. According to *Mian/Smith* (1994) suppliers hold on average about 26% of total corporate debt, in Germany it is about 22-25 %.[2] This is the empirical point of view. From a theoretical perspective, trade credit may be desirable for different reasons, e.g.

(1) if the supplier has a comparative advantage in screening the debtor's quality (*Biais /Gollier*, 1997),

(2) if the supplier has a comparative advantage in liquidating the firm's assets (*Petersen /Rajan*, 1997),

(3) since trade credits can be used as an instrument for price differentiation (*Brennan /Maksimovic/Zechner*, 1988),

(4) since the willingness to give trade credit might signal product quality (*Long/Malitz/ Ravid*, 1994, *Hakenes*, 2003) or might mitigate opportunistic behaviour by the supplier and

(5) if suppliers are more willing to support efficient reorganization in case of financial distress (*Wilner*, 2000).

There might be a less sophisticated reason why we observe trade credits and not bank financing only. In most western European countries as well as in most U.S. states there is a legal ceiling on contractual interest rates. Thus, even if banks are willing to, they are not allowed to demand high interest rates to compensate for higher risk. Surprisingly, in those interest ceilings generally do not hold for trade credits.[3] In the following analysis

[2] The sample of *Mian/Smith* (1994) consists of the annual reports of 3.550 firms that are listed at the Nasdaq and that do not belong to the financial sector. The sample of *Deutsche Bundesbank* (1999) comprises annual reports from more than 50.000 firms in all industries.

[3] Just to give an example. A supplier gives credit for 30 days. If the firm pays within 10 days there is a discount of 2%. If the firm pays after 30 days (credit for 20 days), the implicit annual interest rate is 36,7%. This rate exceeds the current interest ceiling in Germany and probably, in many U.S. states as well.

we assume that the supplier is less likely to perform non-contractible services after he is fully paid (theoretical argument (4)).

2.2 Model set-up

The entrepreneur is manager-owner of a limited liability firm in *t=0*. The firm consists of one **project** with an initial investment of I (I>0) in *t=0*. I is used for labor costs (I_B) and for goods and services delivered by suppliers (I_S) with $I = I_B + I_S$ and $I_S > 0$, $I_B > 0$.

If goods and services are entirely delivered, the project yields a net return of $\bar{x}$ in *t=2* if the good state of nature realizes. With the bad state return is $\underline{x}$ ($\bar{x} > \underline{x} > 0$). The probability of success and failure is p ($0 < p < 1$) and ($1 - p$), respectively.

Return in *t=2* comprises of two components, first the liquidation revenue of the firm's equipment (for instance computers, software), second the revenue of other assets, for instance the firms' claims. The equipment's liquidation revenue in *t=2* is certain and amounts to $\underline{x}$. The revenue of the firm's claims is ($\bar{x} - \underline{x}$) in case of success and 0 in case of failure.

With risk-neutrality and a market rate of 0% for risk-less investments the project is suppose to yield a positive net present value:

(1) $$p\bar{x} + (1-p)\underline{x} = \underline{x} + p(\bar{x} - \underline{x}) > I$$

The firm buys the equipment from suppliers, for simplicity there is only one supplier called S. The supplier provides the goods needed in *t=0*, for instance hardware and software including a guarantee for delivering additional services in *t=1* in case that the goods do not work properly (and that the malfunction is not due to the firm's negligent behaviour). Neither the scope and nature of the services nor "negligent behaviour" can be specified precisely at sufficiently low transaction costs in *t=0*. Since the services in *t=1* cannot be contracted upon the supplier will demand payment in advance. This especially holds true if there is a *legal* requirement on giving a guarantee (as it is in the European Union). The supplier provides goods and services of about $I_S - c$ in *t=0* and - given the specific type of good - is supposed to provide an additional amount of c in *t=1*. Since the services are not verifiable the supplier might shirk on size or quality in *t=1*. With shirking, the liquidation value of the firm's equipment in *t=2* decreases in both states of nature by $b\underline{x}$ ($0 \le b < 1$) with $c < b\underline{x}$ (thus, proving services is efficient).

Three forms of **financing** are possible: (1) pure supplier financing, (2) pure bank financing and (3) financing by both bank and supplier (two creditor or mixed financing). To make the model simpler, we exclude the quite unrealistic case of *pure supplier*

financing, where the supplier takes over the bank debt. This case can be easily ruled out by assuming that the supplier lacks the competence or network to liquidate the firm's claims at high price or that the supplier faces liquidity constraints ($I_L = M < I$, where M denotes the supplier's liquid funds in $t=0$).

In case of *pure bank financing* the supplier's claim (D_S) is fully paid via the bank account in $t=0$, that is, the firm has bank debt only. In $t=2$, the bank's claim amounts to $D_{B+} = D_S + I_B(1 + r_B)$ with $0 < \underline{x} < D_{B+} \leq \bar{x}$, where r_B denotes the contractual interest rate with the bank loan.

Mixed financing means that the supplier's debt is not paid in $t=0$, but in $t=2$. The supplier's claim in $t=2$ is not secured (in the basic model) and amounts to $D_S = I_S(1 + r_S)$ mit $0 < D_L \leq \bar{x}$, where r_S denotes the contractual interest rate with the trade credit.

Bank B has a claim of $D_B = I_B(1 + r_B)$ mit $0 < D_B \leq \bar{x}$ in $t=2$. Total debt does not exceed the project's return in the *good* state of nature - even if the supplier shirks in $t=1$ - but in the bad state of nature ($\underline{x} < D_B + D_S \pounds \bar{x} - ß \cdot \underline{x} < \bar{x}$). Often, trade credits are not backed by collateral because transaction costs, such as costs of evaluation, monitoring etc. are too high, especially if services and not goods are delivered or if there are several suppliers each providing a little fraction.

With both pure bank financing and mixed financing the bank has both internal and external collateral. The firm's claims are taken as (internal) collateral for the bank - which is efficient since the supplier lacks competence of liquidation this kind of asset. Additionally, the entrepreneur's private fortune serves as collateral, for instance a mortgage.[4] For simplicity, the liquidation of the private collateral in $t=2$ yields C with certainty. Since $C < D_B$ holds and the value of internal collateral is zero in the bad state of nature, bank debt is still risky.

The entrepreneurial choice of **repayment policy** is in the focus of the model. Either she repays the bank in $t=2$ or briefly *before* $t=2$ by liquidating *disposable firm's assets* thereby saving private fortune. If the entrepreneur chooses to liquidate prematurely there are losses caused by the "fire sale", especially when there is no market price and when assets are highly specific (see *Shleifer/Vishny*, 1992). The loss in liquidation revenue is $k \cdot D_B$ ($k > 0$). The variable k also covers losses due to the fact that synergies with another firm's assets might get lost, for instance, if a machine is sold that is needed for the production process. If the entrepreneur pays back bank debt in $t=2$, there are lower cost of liquidation, for simplicity we set them to zero. Additionally, it shall hold:

[4] The entrepreneurial private fortune cannot be used for financing the project but for securing the creditor's claim, for instance, because it is not liquid. See for a similar assumption *Bester/Hellwig* (1987), p. 143.

(2) $0 < D_B < (1+k)D_B \leq \underline{x} - \beta\cdot\underline{x} < \underline{x} < D_B + D_S < (1+k)D_B + D_S \leq \bar{x} - \beta\cdot\underline{x} < \bar{x}$

with mixed financing and

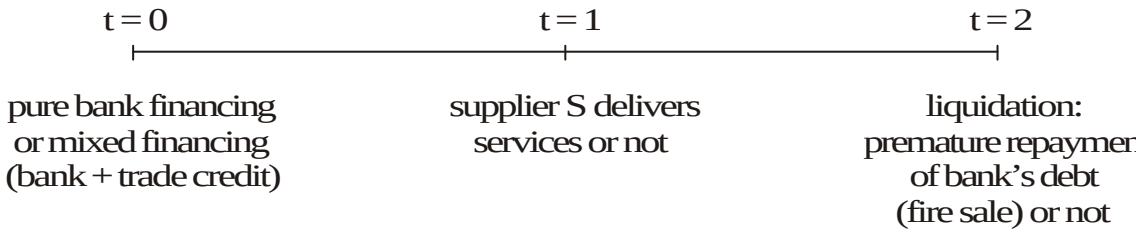
(3) $0 < \underline{x} - \beta\cdot\underline{x} < \underline{x} < D_{B+} = D_B + D_S < (1+k)D_{B+} \leq \bar{x} - \beta\cdot\underline{x} < \bar{x}$

with pure bank financing.

By the assumptions (2) and (3) we reduce the number of cases that have to be analyzed. These assumptions are not crucial, though. (2) states, that with mixed financing, bank debt is not risky if the bank is served prematurely - however, the supplier's claim is risky. With pure bank financing (see (3)) the bank's debt is bigger and also risky. Since then the supplier is paid via the bank account he does not face a default risk.

In *t=1*, the entrepreneur has private information which state of nature will realize in *t=2*. Else, information is distributed symmetrically. Entrepreneur E, bank B and supplier S are risk-neutral. S and B are only able to receive a zero profit due to strong competition in the banking market and the product market, respectively.

Figure 1: Structure of the model



Apparently, we yield the first best if (1) the supplier delivers the non-contractible services in *t=1* and (2) the entrepreneur does not repay the bank prematurely thereby avoiding the liquidation loss due to the fire sale ($k\cdot D_B$). If the supplier does not perform in *t=1*, welfare loss amounts to $\beta\cdot\underline{x} > 0$. In what follows, we investigate the equilibriums with pure bank financing and mixed financing.

2.3 Pure bank financing

With pure bank financing the bank pays the supplier's claim in *t=0*, thus being the only creditor. There is no default risk for S. However, the supplier has poor incentives to provide non-contractible services in *t=1*. There is no marginal benefit to him, but marginal costs ($c > 0$). Hence, the firm's revenue decreases by $ß \cdot \underline{x}$.

Still, in case the *good* state of nature realizes, there is no default risk for the bank (see (3)). Entrepreneur E fully bears the cost of inefficient repayment and will not choose to do so.

(4.1) $R_E^{priv} = \bar{x} - b\,\underline{x} - D_{B+} \quad > \quad R_E^{firm} = \bar{x} - b\,\underline{x} - (1+k)D_{B+}.$

The index "priv" stands for the efficient repayment policy, that is using the private fortune to pay back the bank in *t=2*. The index "firm" is used for the inefficient policy where the entrepreneur pays back the bank prematurely liquidating firm's assets.

In the *bad* state of nature (failure) E does not benefit from premature repayment either since the bank still is allowed to liquidate E's private assets.

(4.2) $$R_E^{priv} = \begin{cases} (1-b)\underline{x} - D_{B+} < 0\,, & D_{B+} \le (1-b)\underline{x} + C \\ -C < 0 & , D_{B+} > (1-b)\underline{x} + C \end{cases}$$

$$= R_E^{firm} = \begin{cases} (1-b)\underline{x} - (1+k)D_{B+} < 0\,, & D_{B+} \le \left[(1-b)\underline{x} + C\right]/(1+k) \\ -C < 0 & , D_{B+} > \left[(1-b)\underline{x} + C\right]/(1+k). \end{cases}$$

Result 1:
With pure bank financing the entrepreneur chooses the efficient repayment policy. There is no loss due to a "fire sale". However, there is a welfare loss since the supplier has no incentive to provide non-contractible services in *t=1*. Social loss amounts to $ß\underline{x}$.

2.4 Mixed financing (with both bank debt and trade credit)

2.4.1 The entrepreneurial repayment policy in *t=2* and the bank's interest

With mixed financing, trade credit amounts to D_S and bank debt to D_B in *t=2*. Which repayment policy the entrepreneur will choose now ? In case of *success* she is better off if she repays the bank in *t=2* since she entirely bears the costs of a fire sale (see (2)):

(5.1) $R_E^{priv} = \bar{x}_j - D_S - D_B \quad > \quad R_E^{firm} = \bar{x}_j - D_S - (1+k)D_B$

with $\bar{x}_j \in \left\{\bar{x}, \bar{x} - b\,\underline{x}\right\}$.

The variable $\bar{x}_j$ considers the supplier's effort choice in *t=1*. If S does not provide services, total revenue decreases by *ß*$\underline{x}$.

In case of failure, the entrepreneur has an incentive to save her private fortune. She might pay back the bank before *t=2* by liquidating disposable firm's assets. Thus, the bank has a claim that is *entirely* senior. According to (2) the firm's assets are sufficient to fully repay the bank ($D_B < (1+k)D_B$ £ $\underline{x}$ - ß·$\underline{x}$ < $\underline{x}$). Entrepreneur E does not receive a positive return from the firm since $\underline{x} < D_B + D_L$ holds (see (2)):

$$(5.2)\quad R_E^{priv} = \begin{cases} \underline{x}_j - D_B - D_S < 0, & C \geq D_B + D_S - \underline{x}_j, \\ -C < 0, & C < D_B + D_S - \underline{x}_j. \end{cases} \quad < \quad R_E^{firm} = 0.$$

$$\text{with} \quad \underline{x}_j \in \{\underline{x}, \underline{x} - b\,\underline{x}\}.$$

Thus, E will choose the inefficient repayment policy. The loss from the fire sale is borne by the supplier, but not by E.

With the inefficient repayment policy in the bad state of nature the entrepreneur is better off, but the bank might be better off, too. Since the bank's claim is partially secured she might benefit from being served first which makes her claim senior to the supplier's debt.

$$(6)\quad R_B^{priv} = \begin{cases} D_B & , D_B \leq \dfrac{D_B}{D_B + D_S}\underline{x}_j + C, \\ \dfrac{D_B}{D_B + D_S}\underline{x}_j + C < D_B & , D_B > \dfrac{D_B}{D_B + D_S}\underline{x}_j + C. \end{cases} \quad = \quad R_B^{firm} = D_B.$$

$$\text{with} \quad \underline{x}_j \in \{\underline{x}, \underline{x} - b\,\underline{x}\}.$$

Note that in the bad state of nature (failure) the bank's internal collateral has no value and that the bank's debt has the same rank as the unsecured supplier's claim.

Result 2:

With mixed financing (both bank debt and trade credit) the entrepreneur benefits from the inefficient repayment strategy. That is, she repays the bank by liquidating firm's assets before bank debt becomes due. The entrepreneur saves private fortune since the bank does not liquidate the entrepreneur's private fortune which serves as external collateral. The bank might benefit, too. The supplier loses.

If the bank has access to the entrepreneurial private information in *t = 1*, because, for instance, as a *housebank* she has close ties to the firm, the bank might support the inefficient repayment strategy.

2.4.2 Supplier's choice

In $t=1$, supplier S decides whether to provide services - which incurs marginal costs of c. S anticipates that the entrepreneur will choose the efficient repayment policy in case of success but the inefficient one in case of failure. In case of success, S will not provide non-verifiable services since there is no benefit to him (there is no default risk anyways, see (2): $D_B + D_S < \bar{x} - ß \cdot \underline{x}$).

In case of failure the bank is served prematurely. The supplier's return is:

(7) $R_S = \underline{x} - (1+k)D_B - c$ with service in $t=1$,
$R_S = \underline{x} - ß\underline{x} - (1+k)D_B$ without service in $t=1$.

In case of failure the supplier faces a default risk which also depends on whether he provides services in $t=1$ or not.

Result 3:
Supplier S anticipates that the entrepreneur chooses the inefficient repayment policy in case of failure. S will provide services if

(9) $c = (1- p)ß\underline{x}$

holds, that is, if the costs of doing so is sufficiently low (c) and if the benefit of the service or the probability of failure ($ß\underline{x}$ and $(1- p)$, respectively) are high enough in order to reduce the default risk. Social loss amounts to $(1- p)k \cdot D_B$, if $c = (1- p)ß\underline{x}$, else $(1- p)k \cdot D_B + ß\underline{x}$.

2.5 Equilibriums

Result 4: There are three possible equlibriums if the social loss does not exceed the project's net present value in (1) in each case.

Table 1: Equlibriums

Mixed financing (loss to fire sale in $t=2$: $(1-p)k\cdot D_B$)	Pure bank financing: no service, but no fire sale	Equilibrium and social loss
$c > (1-p)ß\underline{x}$ (no service in $t=1$) loss: $(1-p)k\cdot D_B + ß\underline{x}$	loss: $ß\underline{x}$	pure bank financing loss: $ß\underline{x}$
$c = (1-p)ß\underline{x}$ (service provided) loss: $(1-p)k\cdot D_B$	loss: $ß\underline{x}$ ($< (1-p)k\cdot D_B$)	pure bank financing loss: $ß\underline{x}$
	loss: $ß\underline{x}$ ($= (1-p)k\cdot D_B$)	mixed financing loss: $(1-p)k\cdot D_B$

If social loss exceeds the project's net present value in (1), that is, if holds

(10) $ß\underline{x} > p\bar{x} + (1-p)\underline{x} - I$ or $(1-p)k\cdot D_B > p\bar{x} + (1-p)\underline{x} - I$,

the project will not be undertaken in $t = 0$ (underinvestment). Underinvestment is the more likely to occur,

- the more valuable the non-contractible supplier's service in $t = 1$ (that is, the larger the amount of services that are non-contractible),
- the more likely the bad state of nature (failure) is to occur and
- the higher the losses due to inefficient repayment/liquidation (determined by k).

There is one important finding with mixed financing. If there are two creditors that are *asymmetrically* secured, a special moral hazard problem might occur. If the entrepreneur was not held liable with his private fortune for the bank's debt there would be no incentive for inefficient repayment. In the present model, external collateral might induce a social loss as opposed to many models where external collateral is welfare-increasing, for instance, by mitigating or eliminating entrepreneurial moral hazard (see, for instance, *Stiglitz/Weiss* (1981), *Bester* (1985), *Besanko/Thakor* (1987) and *Schmidt-Mohr* (1997) for problems of adverse selection and *Bester* (1994) for moral hazard problems).

In case of mixed financing the supplier will anticipate that the entrepreneur might choose the inefficient repayment strategy thereby devaluing the supplier's claim. Thus,

the supplier will demand a specific risk premium. The special moral hazard problem presented here might explain why trade credit is quite expensive in reality or why suppliers are not even willing to grant trade credit at all. Either way, the entrepreneur has to bear the cost of inefficient repayment. Hence, she is interested in contractual solutions to credibly overcome the incentive problem.

3. Mixed financing: contractual provisions mitigating the incentive for inefficient repayment

3.1 Formal analysis of securing trade credit by firm's assets (internal collateral)

If the entrepreneur *credibly* commits not to repay bank's debt prematurely, she will not have to bear the costs of this moral problem ex ante. Once, however, the bad state of nature (prior to bankruptcy) realizes there is an incentive for inefficient repayment. Of course, the entrepreneur should commit by contract not to do so, accompanied by severe sanctions, for instance, damage compensation. Still, we cannot observe such contractual provisions in practice. The sanction of paying damage compensation only works if the entrepreneur has money left over in case of bankruptcy. Moreover, such a contractual provision only works if there is no obligation to pay the bank's debt prematurely, for instance, when the bank calls in the debt. The right to call in cannot be restricted by the contract between entrepreneur and supplier. It seems that another contractual provision would work better requiring that the entrepreneur first liquidates private assets in case she repays bank's debt prematurely. Still, we cannot observe such provisions either, maybe because there is a lack of effective sanctions.

Are there other ways to mitigate the incentive for premature repayment ? The problem basically arises since the supplier's debt is risky. At first sight, two contractual strategies are of interest. First, high contractual interest rates can compensate for the supplier's special default risk. However, high interest rates do not mitigate the moral hazard problem. Still, we can observe them in reality. Second, the entrepreneur might look for ways to reduce the supplier's default risk. If the supplier's default risk decreases, the moral hazard problem is mitigated as well. Two instruments are of special interest:

(a) Collateral to secure supplier's debt

(b) and short-term dates of payments.

Both instruments are widely used in practice. First we analyze the impact of collateral in the model. Thus, we now additionally assume:

In *t=2*, supplier S has a claim of D_S. The claim is secured by firm's assets (internal collateral) with a safe liquidation value of $a\underline{x}_j$ in *t=2*, with $0 < a \leq 1$ and $\underline{x}_j \in \{\underline{x}, \underline{x} - b\underline{x}\}$. Hence, the disposable assets that the entrepreneur could use for premature repayment of bank's debt shrink to $(1 - a)\underline{x}_j$. If the entrepreneur chooses the inefficient repayment policy the loss due to the "fire sale" amounts to $k(1 - a)\underline{x}_j$. For simplicity, we look at the case $D_B + D_S \leq C + \underline{x}_j$ or rewriting: $D_B \leq - D_S + C + \underline{x}_j$, that is, the bank does not do better with the inefficient repayment policy since she does not bear a default risk anyways. Since we also assume $D_B > C$, it must hold $D_S < \underline{x}_j$.

In the good state of nature the supplier's collateral does not change anything since there is no default risk. In case of failure, the entrepreneur has an incentive to save her private fortune. She might pay back the bank before *t=2* by liquidating disposable firm's assets. Thus, the entrepreneur's return in the bad state of nature equals to - dependent on the repayment policy:

(11) $R_E^{priv} = \underline{x}_j - D_B - D_S < 0$ (for $D_B \leq - D_S + C + \underline{x}_j$, see (5.2))

$$R_E^{firm} = \begin{cases} \underline{x}_j - D_S - k(1-a)\underline{x}_j - D_B < 0 \;, D_S \leq a\underline{x}_j \,, \\ \underline{x}_j - a\underline{x}_j - k(1-a)\underline{x}_j - D_B \quad , D_S > a\underline{x}_j \,. \end{cases}$$

with $\underline{x}_j \in \{\underline{x}, \underline{x} - b\underline{x}\}$.

From (11), we can derive two cases.

- If $D_S \leq a\underline{x}_j < \underline{x}_j$, there will be no incentive for inefficient repayment anymore, the entrepreneur will entirely bear the cost of doing so.
- In the case $a\underline{x}_j < D_S < \underline{x}_j$, the entrepreneur might still choose the opportunistic repayment strategy, if holds: $a\underline{x}_j + k(1 - a)\underline{x}_j < D_S$. Else, she goes for the efficient repayment policy.

Thus, if the supplier is not fully secured, the moral hazard problem with mixed financing might still exist. Still, internal collateral tends to mitigate. Of course, it is important that this collateral is valuable, which especially means that the entrepreneur cannot influence the liquidation value of this collateral. This, of course, heavily depends on the nature of the security and on the legal framework on collaterals. We will discuss this point in more detail later on (section 3.2).

What is the choice of supplier S now ? S knows that in case of failure the entrepreneur will choose the efficient repayment policy if $D_S \leq a\underline{x}_j + k(1 - a)\underline{x}_j$ holds, else the opportunistic one. In case of success, S will not provide non-verifiable services since there is no benefit to him (there is no default risk anyways, see (2): $D_B + D_S < \bar{x} - ß \cdot \underline{x}$).

In case of failure the bank was served prematurely - in the basic model. With collateral this might be different. The supplier's return in *t=2* depends on how much of his claim is secured:

$$(12)\quad R_S = \begin{cases} D_S & , D_S \le a\,\underline{x}_j , \\ \min\left[D_S, a\,\underline{x}_j + \dfrac{D_S}{D_B + D_S}(1-a)\underline{x}_j \right] & , a\,\underline{x}_j < D_S \le a\,\underline{x}_j + k(1-a)\underline{x}_j , \\ a\,\underline{x}_j & , a\,\underline{x}_j + k(1-a)\underline{x}_j < D_S < \underline{x}_j . \end{cases}$$

$$\text{with} \quad \underline{x}_j \in \{\underline{x}, \underline{x} - b\,\underline{x}\} .$$

Term (11) suggests that the entrepreneur will choose the efficient liquidation policy if D_S £ $a\underline{x}_j + k(1-a)\underline{x}_j$ holds. Thus, in the first two cases of (12), the supplier expects the "usual" efficient liquidation process. If the supplier's claim is sufficiently secured (D_S £ $a\underline{x}_j$), he does not expect a default risk, if it is not, he receives a revenue from his collateral ($a\underline{x}_j$), and shares the rest of the firm's assets ($(1-a)\underline{x}_j$), with the bank, in proportion to the size of the unsecured claim. In the third case ($D_S > a\underline{x}_j + k(1-a)\underline{x}_j$), the supplier takes into account the opportunistic repayment policy and expects a return that amounts to the value of his collateral.

Does the supplier provide services in *t=1* if his claim is collateralized ? Apparently, there will be no incentive to do so, if the claim is not risky at all ($R_S = D_S$), that is, if it is sufficiently secured. Only in the second and third case of (12) S will be willing to provide services, if (13.1) or (13.2) holds:

$$(13.1)\quad c < (1-p)\left[ab\,\underline{x} + \frac{D_S}{D_B + D_S}(1-a)\,b\,\underline{x} \right] \qquad , a\,\underline{x}_j < a\,\underline{x}_j + \frac{D_S}{D_B + D_S}(1-a)\underline{x}_j < D_S \le a\,\underline{x}_j + k(1-a)\underline{x}_j ,$$

$$(13.2)\quad c < (1-p)ab\,\underline{x} \qquad , a\,\underline{x}_j + k(1-a)\underline{x}_j < D_S < \underline{x}_j .$$

Apparently, condition (13.1) is easier to be fulfilled than (13.2). Compared to (9) in the basic model, there is less of an incentive to provide services in *t=1*. For instance, looking at (13.2), if $(1-p)ab\,\underline{x} < c < (1-p)b\,\underline{x}$ holds the supplier will provide services in the basic model (without collateral) but not with a secured claim. A similar consideration applies to (13.1). To sum up, collateral might distort the supplier's incentives. Surprisingly, it rather holds for the case reflected by (13.2) than by (13.1) since condition (13.1) is easier to fulfill than (13.2).

Equlibriums. With the supplier holding internal collateral we end up with different equilibriums than in the basic model. Table 2 provides an overview. Again, we assume

that social loss does not exceed the project's net present value in (1) (else: the project is not undertaken).

Table 3: Equlibriums if the supplier holds collateral on firm's assets with mixed financing (value of collateral: $a\underline{x}_j$, supplier's claim: D_S)

Case	Mixed financing	Pure bank financing (efficient repay-ment, no service)	Equlibrium and social loss
$D_S \leq a\underline{x}_j$ or $a\underline{x}_j < D_S < a\underline{x}_j + \frac{D_S}{D_B + D_S}(1-a)\underline{x}_j$ *(fully secured or non-risky)*	efficient repayment of bank's debt in *t=2*, *no* service in *t=1*, *loss: ß$\underline{x}$*	*loss: ß$\underline{x}$*	either case, *loss: ß$\underline{x}$*
$a\underline{x}_j < D_S \leq a\underline{x}_j + k(1-a)\underline{x}_j$ $c \geq (1-p)\left[ab\underline{x} + \frac{D_S}{D_B + D_S}(1-a)b\underline{x}\right]$	efficient repayment of bank's debt in *t=2*, *no* service in *t=1*, *loss: ß$\underline{x}$*	*loss: ß$\underline{x}$*	either case, *loss: ß$\underline{x}$*
$a\underline{x}_j < D_S \leq a\underline{x}_j + k(1-a)\underline{x}_j$ $c < (1-p)\left[ab\underline{x} + \frac{D_S}{D_B + D_S}(1-a)b\underline{x}\right]$	efficient repayment of bank's debt in *t=2*, service in *t=1*, *loss: 0*	*loss: ß$\underline{x}$*	mixed financing. *loss: 0*
$a\underline{x}_j + k(1-a)\underline{x}_j < D_S < \underline{x}_j$ $c \geq (1-p)ab\underline{x}$	*in*efficient repayment of bank's debt in *t=2*, *no* service in *t=1*, *loss: ß$\underline{x}$+k(1- a)(1- ß)$\underline{x}$*	*loss: ß$\underline{x}$*	pure bank financing. *loss: ß$\underline{x}$*
$a\underline{x}_j + k(1-a)\underline{x}_j < D_S < \underline{x}_j$ $c < (1-p)ab\underline{x}$	*in*efficient repayment of bank's debt in *t=2*, service in *t=1*, *loss: k(1- a)(1- ß)$\underline{x}$*	*loss: ß$\underline{x}$*	depends, whatever loss is lower *loss: min(ß$\underline{x}$; k(1- a)(1- ß)$\underline{x}$)*

Result 4:

If the supplier's loan is covered by internal collateral (that is, firm assets), the entrepreneur is less able to repay total bank's debt prematurely, since both the amount of disposable firm assets and the costs of premature repayment are smaller. In some cases, internal collateral even eliminates the opportunistic incentive. On the other hand, collateral weakens the supplier's incentive to provide non-contractible services in *t=1*. There is a richer set of possible equilibriums. Under certain circumstances, with mixed financing and collateral, even the first-best is achievable (zero loss). This equilibrium, requires, for instance, that supplier's debt is secured only partially and thus, risky.

3.2 Discussion: internal collateral and short-term payments dates of payment

Note that the supplier's default risk is only reduced with internal collateral if it is of lasting value. Often that might not be the case - due to the nature of the volatility of the asset's value or due to entrepreneurial moral hazard. Sometimes the entrepreneur still needs and is allowed to use the collateral in the firm (for example pledged machines for the production process). However, prior to bankruptcy the entrepreneur might abuse his discretion especially if there is no register on collateral (as, for instance, it is the case for moveable collateral in Germany). Table 3 provides an overview on reasons why moveable internal collateral loses value in Germany.

Table 3: Relevance of different reasons why internal moveable collateral lost value in Germany (in %)

Reason for default	**with collateralized trade credits**	**with collateralized bank credits**
Collateral was not existing anymore	41.8	14.6
Liquidation value of collateral did not cover claim	18.4	42.5
Different creditors had claims on the same collateral	9.5	26.0
Collateral could not be precisely determined	12.0	9.8
Other causes	18.3	7.1

Source: *Drukarczyk/Duttle/Rieger* (1985), pp. 92, 132f. Based on the answers of 214 banks and 83 non-banks

Different types of collateral imply different degrees to which the credit risk is covered. This depends very much on the legal framework. Usually the safest security are mortgages but also the transaction costs are high. Thus, for small trade credit volumes mortgages do not seem to be a suitable way to secure the credit risk and it is not common in practice either.

(*Short-term based dates of payment*): Usually, the dates of payments are much more short-term with trade credit than with bank debt. Of course, it also depends on the nature of the goods and services delivered. Often, suppliers demand payment in a few weeks after delivery. Thus, suppliers are less likely to suffer from premature repayment

of bank's debt since the supplier often will be served first, thus his claim becomes senior. Thus, the entrepreneur cannot benefit anymore by choosing the inefficient repayment strategy. Hence, short-term dates of payments are an apparently cheap contractual device to eliminate this moral hazard problem.[5] Since interest rates on trade credits are quite high, an entrepreneur also has an incentive to pay quickly. The model explains why this contractual instrument might be useful from an economics perspective.

Result 5:
Short-term based dates of payment might be welfare-increasing, since the supplier is more likely to be paid first and thus, premature repayment of bank's debt does not pay for either the entrepreneur or the bank.

4. Conclusion

This article looks at a special moral hazard problem that only occurs if there are different creditors, for instance a bank and a supplier. The entrepreneur will behave opportunistically prior to bankruptcy if the bank loan is secured by external collateral and the trade credit is not secured. In order to save her private fortune, the entrepreneur may be tempted to repay the bank by liquidating the firm's assets before bank debt becomes due (premature repayment). Even the bank might benefit. The unsecured supplier will lose. From an economics point of view premature repayment is not desirable if it incurs a special loss, for instance from the pressure to liquidate firm's assets quickly (fire sale).

A rational supplier will anticipate the special default risk that stems from the premature repayment. He will demand higher interest rates for compensation or even deny to give credit and to supply goods/services even though the entrepreneur's project might yield a positive net present value (NPV). This underinvestment problem occurs if the social loss from premature repayment exceeds the NPV.

With pure bank financing - thus, paying the supplier via the bank account - the problem does not occur. However, then the supplier may have poor incentives to provide non-verifiable services later on. Whether pure bank financing or mixed financing (with bank and supplier) is desirable depends on the specific social loss with either type of financing (as long as the NPV of the project exceeds social loss).

[5] Still, another problem of premature repayment might occur if the supplier holds collateral on the entrepreneur's private assets but not the bank. In practice, however, this case is not common.

With mixed financing, internal collateral that secures the supplier's claim and short-term dates of payments mitigate the entrepreneurial moral hazard problem. The first instrument reduces the amount of disposable assets - disposable assets are a basic requirement for premature repayment. Short-term dates of payment usually make the supplier's claim senior, thus the inefficient repayment strategy does not pay anymore for the entrepreneur. Hence, our model can explain both why short term dates of payment and internal collateral are widely used in the practice of trade credit.

It is important to note that special problems of moral hazard might occur if creditor have secured their claims in different ways. In our model, external collateral might *induce* a welfare loss.

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